

## **Provide the FORA for ONR Sponsored NPAL 04 Experiment**

John R. Preston and Kyle M. Becker  
Applied Research Laboratory  
The Pennsylvania State University  
State College, PA 16804-0030  
phone: 814-863-4159 fax: 814-863-8783 e-mail: [kmbecker@psu.edu](mailto:kmbecker@psu.edu)

Award Number: N00014-04-1-0011

### **LONG-TERM GOALS**

Provide for towed array operation and data collection using the Five Octave Research Array (FORA) in support of the 2004 North Pacific Acoustic Laboratory Experiment.

### **OBJECTIVES**

Provide data collection and archiving capabilities for deep-water long-range acoustic propagation experiments in support of acoustic propagation, coherence, and fluctuation studies.

Gain understanding of fundamental limits to signal processing imposed by oceanographic and environmental conditions including internal waves, breaking sea surface waves, shipping noise, and bathymetric effects.

### **APPROACH**

The new ONR Five Octave Research Array (FORA) was prepped and shipped to Honolulu, HI for installation aboard the R/V Roger Revelle for a 1 month sea-trial. The system was configured to collect data as required by the Chief Scientists (A.B. Baggeroer and K.D. Heaney) in accordance with the test plan. The array was operated almost continuously throughout the sea-trail with 4 operators working in pairs, each pair taking a 12 hour shift. Array attitude (depth and heading) and acoustic channel data were continuously monitored to insure proper and safe operations. Array operators were also responsible for data acquisition, archiving, and redistribution throughout the course of the sea trial. Locally, data were archived on Ultra 320 SCSI disk drives and also transferred via FTP to MIT/WHOI machines for duplication and data processing.

20050725 019

## WORK COMPLETED

The FORA was mobilized and installed on the R/V Roger Revelle for the 2004 NPAL/BASSEX sea trial. The array was in operation for over 350 hrs over 22 days at sea. The array was deployed as both a towed array and a vertical array. 4500 Gbytes of data was collected in 316 files capturing over 900 acoustic transmissions. Transmission times and corresponding file sized varied from 20 minutes/10 Gbytes to over 80 minutes/30 Gbytes. Of the 160 acoustic channels recorded, 3 were found to be bad during the sea trial. At the conclusion of the sea trial, the array was removed from the ship, packaged and shipped back to Penn State.

## RESULTS

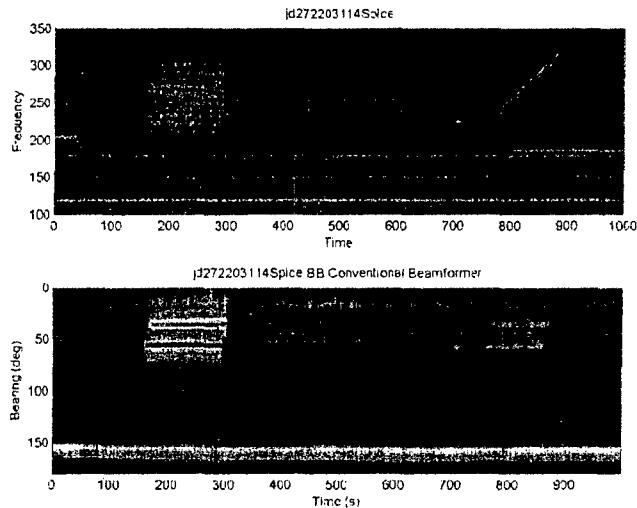
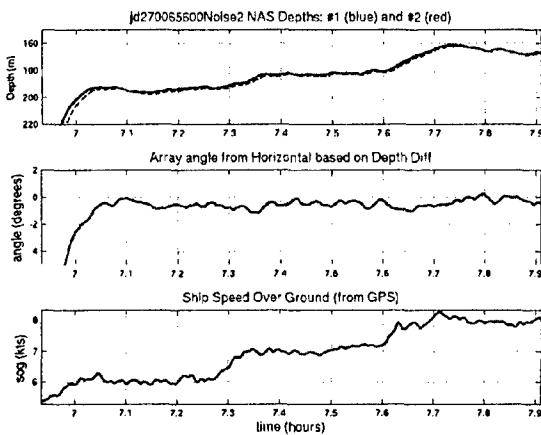


Figure 1: Sample FORA reception for simultaneous S1 and S2 transmissions

The FORA was successfully employed during the NPAL 04 experiments to collect over 4500 Gbytes of high-fidelity acoustic propagation data. Preliminary science results can be found in [1][2]. Data quality for this first deep-water, long-range propagation application of the FORA was very high. Fig. 1 shows data on a single channel along with the beam-formed output for sources S1 and S2 transmitting simultaneously 135 s M-sequences follow by LFM sweeps. The two sources were separated by a distance of 500 km with the receiver towed from North to South along a line between them. During a particular reception, the ship was steered at an angle to the two sources to separate the arrivals in beam space. Taking a closer look at the acoustic data it was determined that the array sampling clocks would periodically lose synchronization on select channels during a

recording. The source of the error was identified while at sea and a software fix has been proposed for future sea trials. During the sea trial, the array attitude proved to be stable and well behaved either when towed or deployed vertically. The array depth and horizontal tilt are shown as tow speed is increased incrementally in Fig. 2.



*Figure 2: FORA depth and horizontal tilt as a function of tow speed. Depth sensors are separated by 108 m.*

## IMPACT/APPLICATIONS

This was the first deep water application of the FORA. The array proved to be a versatile tool for deep water long range propagation work. The array data acquisition system and clock schemes will be refined and updated to meet the needs of future experimental work using the FORA.

## RELATED PROJECTS

The FORA was used in the ONR Ocean Acoustics sponsored GeoClutter experiment in 2003.

## PUBLICATONS

- [1] A.B. Baggeroer and K.D. Heaney, Forward Scattering from the Kermit-Roosevelt Seamount complex during the BASSEX -LOAPEX-SPICEX experiments, *Proceedings of the 1<sup>st</sup> International Conference on Underwater Acoustic Measurements: Technologies & Results*, eds. J.S. Papadakis and L Bjorno, Heraklion, Greece (28 June – 1 July, 2005)

[2] K.D. Heaney, A.B. Baggeroer, K.M. Becker, E.K. Scheer, and K. von der Heydt, Range Dependent Propagation off a Seamount, *Proceedings of the 1<sup>st</sup> International Conference on Underwater Acoustic Measurements: Technologies & Results*, eds. J.S. Papadakis and L Bjorno, Heraklion, Greece (28 June – 1 July, 2005)

K.M. Becker, A.B. Baggeroer, K.D. Heaney, E.K. Scheer, and K. von der Heydt, ONR Five-Octave Research Array Performance during BASSEX 04, *Proceedings of the 1<sup>st</sup> International Conference on Underwater Acoustic Measurements: Technologies & Results*, eds. J.S. Papadakis and L Bjorno, Heraklion, Greece (28 June – 1 July, 2005)

REPORT DOCUMENTATION PAGE				Form Approved OMB No. 0704-0188		
<p>The public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing the burden, to Department of Defense, Washington Headquarters Services, Directorate for Information Operations and Reports (0704-0188), 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to any penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number.</p> <p><b>PLEASE DO NOT RETURN YOUR FORM TO THE ABOVE ADDRESS.</b></p>						
1. REPORT DATE (DD-MM-YYYY) 20-07-2005		2. REPORT TYPE Final		3. DATES COVERED (From - To) Jan-Dec 2004, July 2005		
4. TITLE AND SUBTITLE  Provide the FORA for ONR Sponsored NPAL 04 Experiment			5a. CONTRACT NUMBER N00014-04-1-0011  5b. GRANT NUMBER N00014-04-1-0011  5c. PROGRAM ELEMENT NUMBER N/A			
6. AUTHOR(S) John R. Preston Kyle M. Becker			5d. PROJECT NUMBER N/A  5e. TASK NUMBER N/A  5f. WORK UNIT NUMBER N/A			
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)  Applied Research Laboratory Penn State University P.O. Box 30 State College, PA 16804-0030				8. PERFORMING ORGANIZATION REPORT NUMBER N/A		
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)  Office of Naval Research 875 North Randolph St, 10th Floor Arlington, VA 22203				10. SPONSOR/MONITOR'S ACRONYM(S) ONR  11. SPONSOR/MONITOR'S REPORT NUMBER(S) N/A		
12. DISTRIBUTION/AVAILABILITY STATEMENT  Distribution Unlimited						
13. SUPPLEMENTARY NOTES N/A						
14. ABSTRACT  The ONR Five Octave-Research Array (FORA) was employed as the primary receive system for the Basin Acoustic Seamount Scattering Experiment (BASSEX) in Sept-Oct. 2004. Operating the deep North Pacific, this was the first deep water application of the FORA. Array operation and performance are described along with an assessment of data quality for the sea trial. The array proved to be a versatile tool for this test and for future work.						
15. SUBJECT TERMS  Array Measurements, Deep Water Sound Propagation						
16. SECURITY CLASSIFICATION OF: a. REPORT unclassified		b. ABSTRACT unclassified	c. THIS PAGE unclassified	17. LIMITATION OF ABSTRACT unlimited	18. NUMBER OF PAGES 5	19a. NAME OF RESPONSIBLE PERSON John R. Preston  19b. TELEPHONE NUMBER (Include area code) 814-863-1310